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(71) Applicant H—C Industries Inc. (USA—Indiana), P.O. Box 472, Crawfordsville, Indiana 47933, United States of America
(72) Inventors Sheldon L. Wilde, Thomas J. McCandless, Robert M. Saunders
(74) Agent and/or Address for Service Kilburn and Strode, 30, John Street, London WC1N 2DD

(54) Moulding closures for containers

(57) A plastic closure (10) comprises a cap (12) with a liner (24) which is retained in position by a lip (30) spaced from the top (14) of the cap and projections (36) integral with the cap and extending into the liner. The cap includes a pilfer band (38) which is connected to the skirt portion (16) of the cap by ribs (48) and which is defined by a score line (46) which extends partially into the ribs (48). The pilfer band (38) is formed with inwardly directed, obliquely oriented wings (42) which engage beneath a locking ring on the container to produce separation of the pilfer band when the cap is removed from the container. The cap is produced by compression moulding apparatus (Fig. 4) comprising a female mould (54) and a male mould (52), the male mould having recesses for the projections (36), the ribs (48) and the wings (42). The male mould also includes an outer sleeve (72) in which the remainder of the male mould slides and which engages the female mould to guide the male mould accurately into the female. The liner (24) is moulded separately by depositing a quantity of plastic material into the formed cap and compression moulding the material therein, Fig. 3E (not shown).

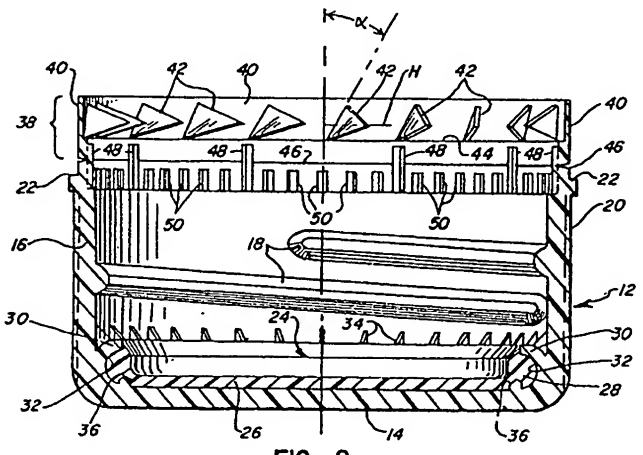

FIG. 2

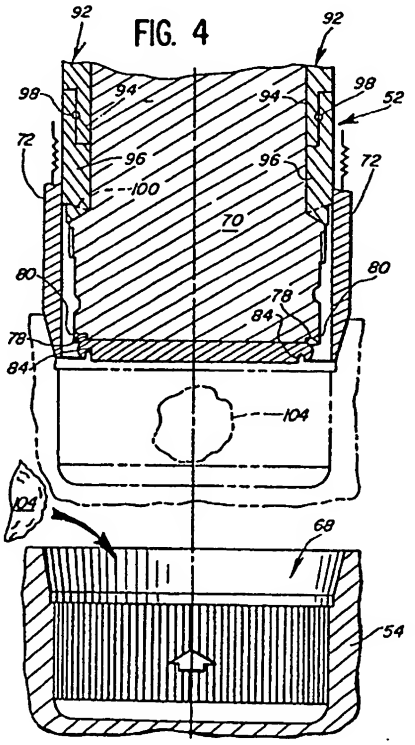

FIG. 4

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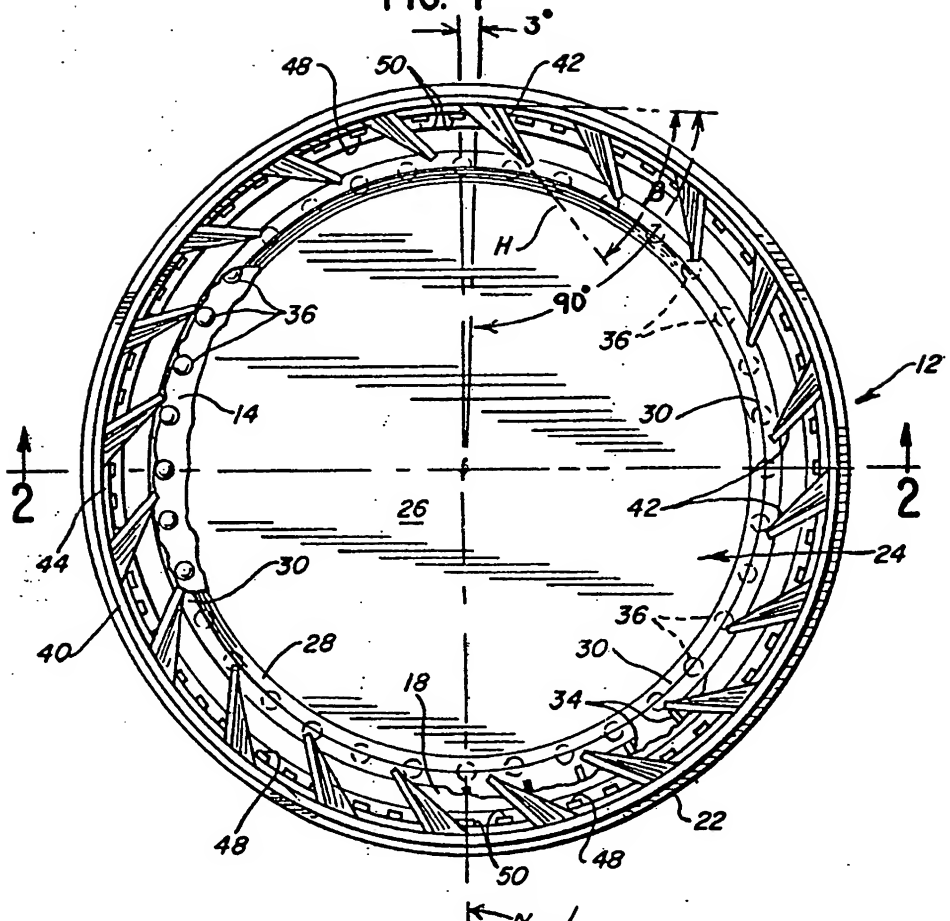
FIG. 1


3°
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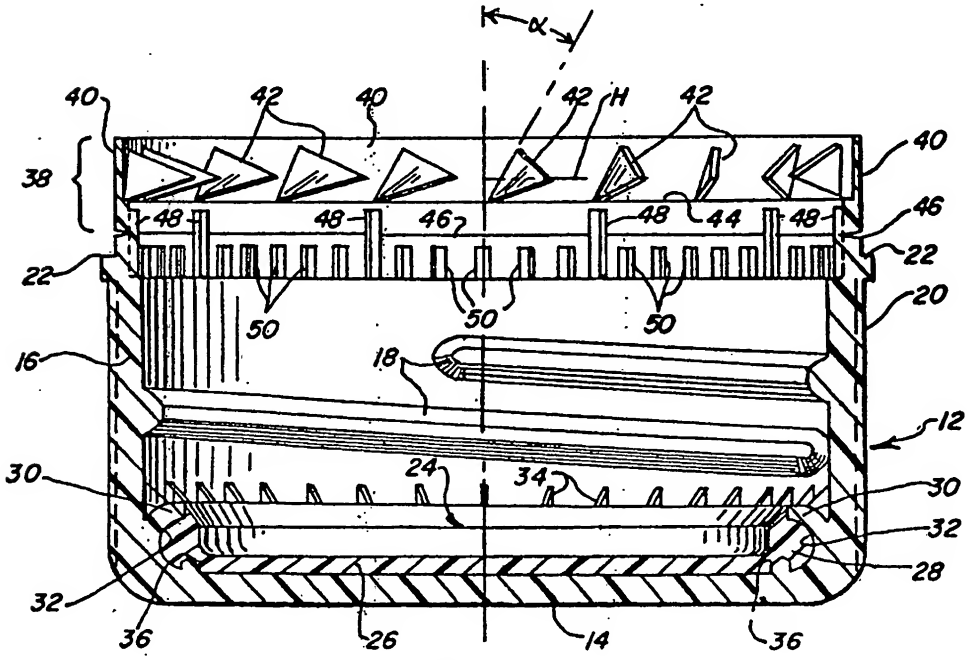
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FIG. 2

FIG. 3A

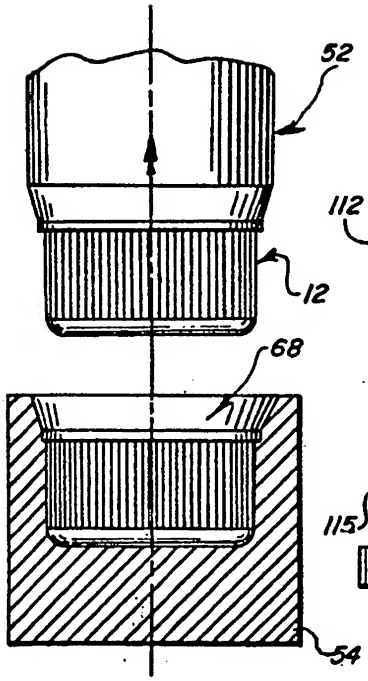


FIG. 3B

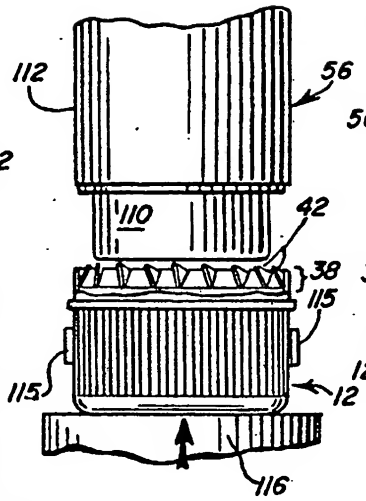
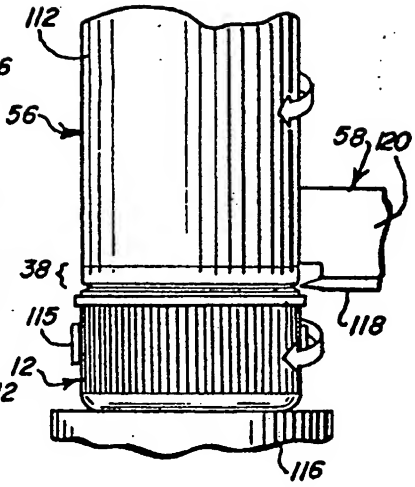


FIG. 3C



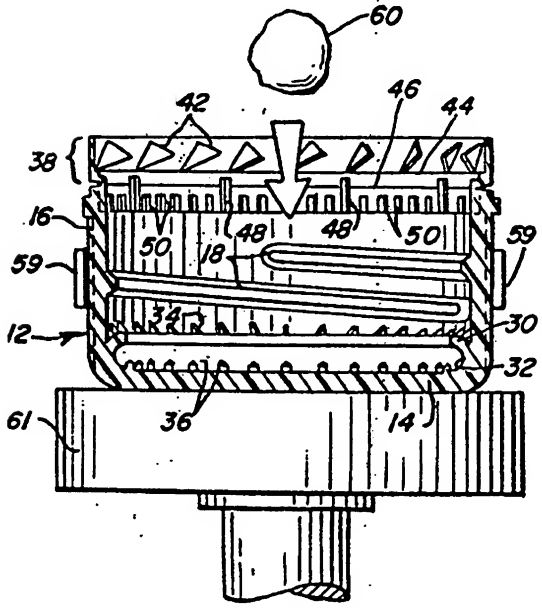


FIG. 3D

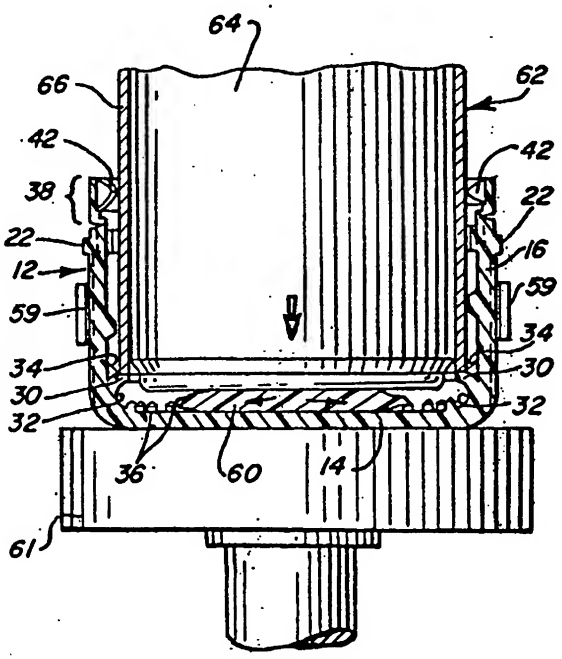


FIG. 3E

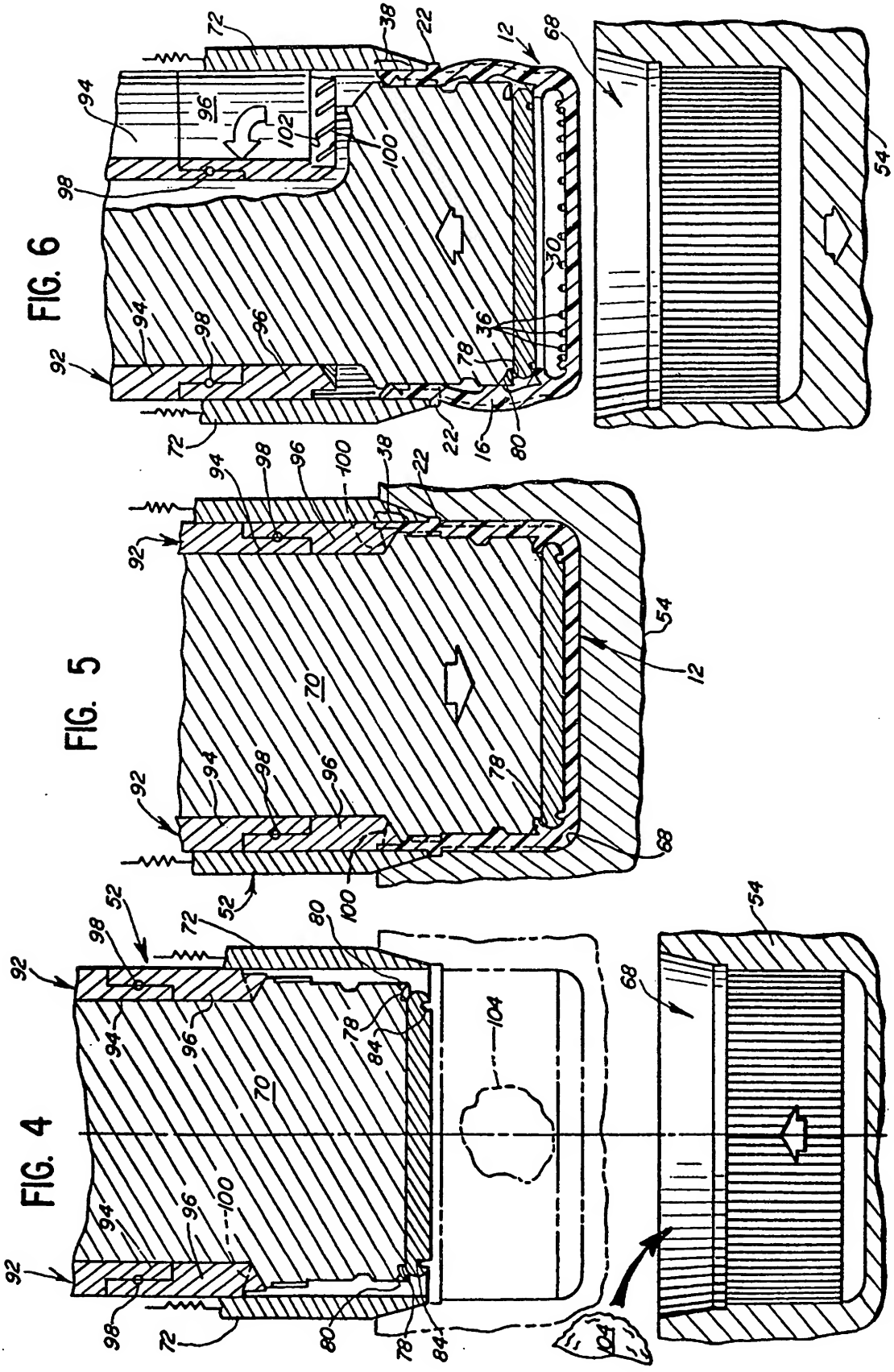


FIG. 6
FIG. 5
FIG. 4

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FIG. 7

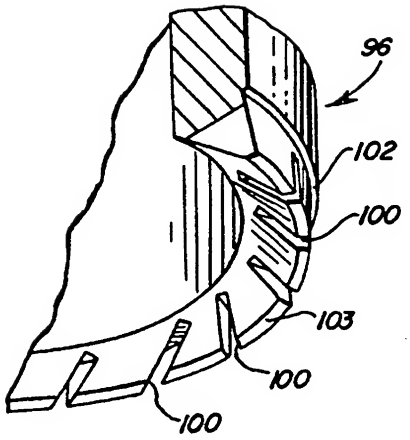


FIG. 8

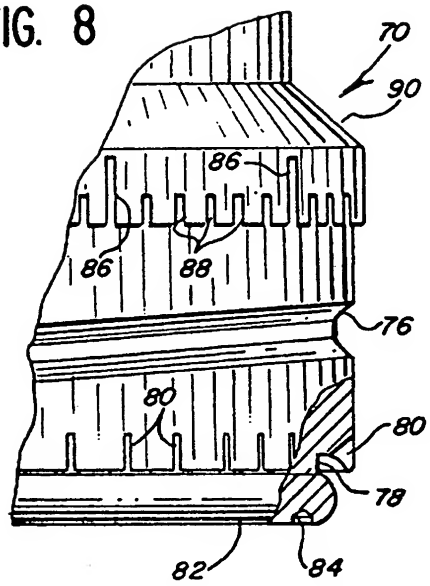


FIG. 9

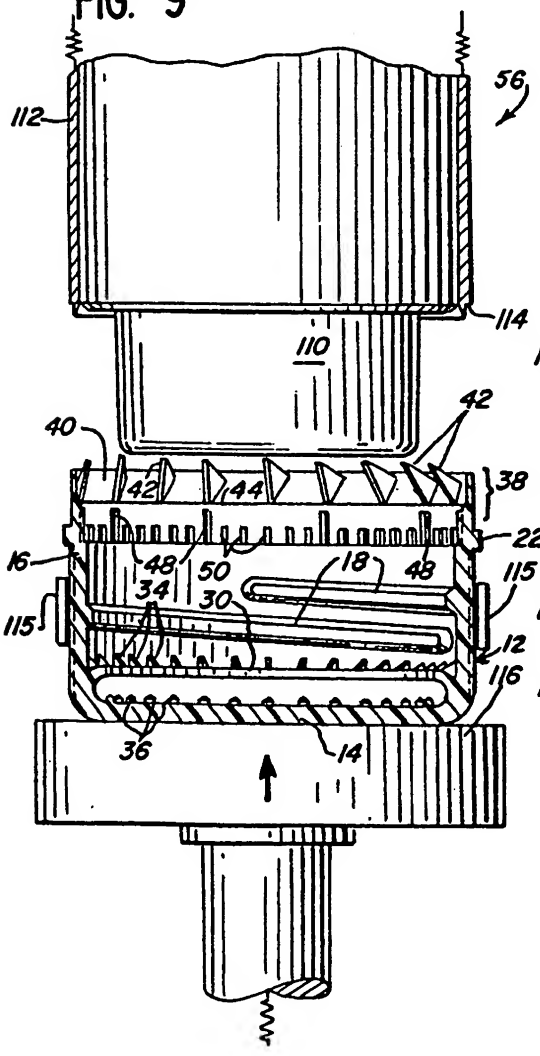


FIG. 10

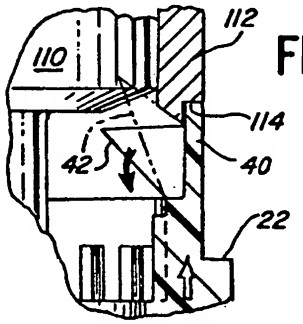
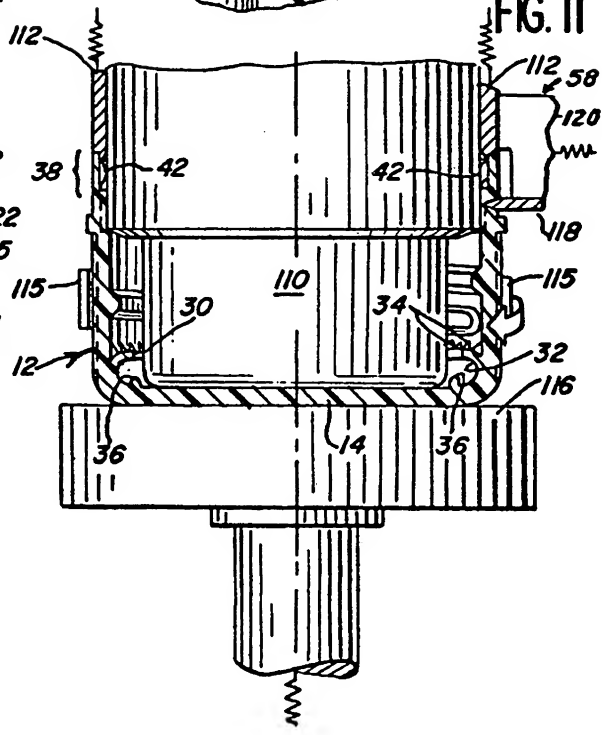


FIG. 11



SPECIFICATION

Improvements in and relating to closures for containers

This invention relates generally to the formation of closures for containers, and more particularly to closure-making processes, apparatus for making closures and to the closures themselves.

As discussed in the specification accompanying EPC application 80.105620.1, various techniques are known for the manufacture of closures for bottles and like containers. More recently, the advantages of the use of plastic closures have been recognized, although problems have been encountered in designing and manufacturing a plastic closure having the requisite strength and sealing capabilities. In this regard, the EPC specification referred to above describes a process and apparatus for manufacture of plastic closures which have proved quite successful.

According to one aspect of the present invention, a process of making a composite closure for a container comprises the steps of: forming a plastic cap having a top wall portion, an annular skirt portion, an inwardly extending, annular liner-retaining lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of liner-engaging projections integral with said top wall portion and at least partially disposed within said annular recess; depositing a quantity of moldable plastic in said cap; and forming a liner with said moldable plastic so that said moldable plastic flows into said annular recess and against said lip, said lip and said projections cooperating to retain said liner within said cap.

According to a second aspect of the present invention, a process of making a composite closure for a container comprises the steps of: compression molding a plastic cap having a top wall portion, an integral annular skirt portion, an internal thread formation on said skirt portion adapted to cooperate with a like thread formation on said container, an inwardly extending annular lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of circumferentially spaced liner-engaging projections integral with said top wall portion and at least partially disposed within said annular recess; depositing a quantity of moldable, liner-forming plastic in said cap; and compression molding said moldable plastic so that said plastic flows into said annular recess to form a sealing liner in said cap having an annular sealing bead portion at least partially disposed within said annular recess, said projections engaging said bead portion and cooperating with said annular lip to retain said liner within said cap.

According to a third aspect of the present invention, an apparatus for making a composite closure for a container comprises: molding means for forming a plastic cap having a top wall portion, an annular skirt portion, an inwardly extending annular liner-retaining lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of liner-engaging projections at least partially disposed in said annular recess; means for depositing a quantity of moldable plastic in said cap; and means for forming a sealing liner with said moldable plastic so that said moldable plastic flows into said recess and against said lip whereby said lip cooperates with said projections to retain said liner within said cap.

According to a fourth aspect of the present invention, a composite closure for a container comprises: a plastic cap having a top wall portion, an annular threaded skirt portion, an inwardly extending annular lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of circumferentially spaced projections integral with said top wall portion at least partially disposed within said annular recess, and a plastic sealing liner disposed adjacent said top wall portion and including an annular sealing band portion engaged by said annular lip, said annular lip and said projections cooperating to retain said liner within said cap.

In addition to exhibiting the requisite strength and sealing properties, some closures must be formed with a tamper-indicating pilfer band. Most previously known pilfer band arrangements require that the container to which the closure is applied includes a specially shaped surface for coaction with the pilfer band, or require additional manufacturing steps after the closure is applied to a container so that the pilfer band correctly coacts with the container for indicating closure removal.

According to a further aspect of the present invention, a process of making a closure for a container having a locking ring comprises the steps of: compression molding a plastic cap having a top wall portion, an annular skirt portion, and a pilfer band depending from said skirt portion; said pilfer band having an annular band portion at least partially detachably connected to said skirt portion and including a plurality of relatively flexible, inwardly extending projections integral with said band portion, said projections being dimensioned to engage said locking ring during removal of said closure from said container for at least partially detaching said pilfer band from said annular skirt portion. The projections, which may take the form of wings, are adapted to engage the container during closure removal so that the pilfer band is at least partially detached from the plastic cap of the closure. Significantly, the pilfer band formed is "self-engaging" in nature, and functions to indicate partial or complete closure removal without the use of specially configured containers, and without the need for further manufacturing steps after the closure is applied to a container.

According to a yet further aspect of the present invention, a process of making a closure comprises the steps of: compression molding a plastic cap having a top wall portion, an annular skirt portion and a pilfer band depending from said skirt portion, including molding a plurality of ribs extending between the internal surfaces of said

skirt portion and said pilfer band, and scoring said closure to distinguish said skirt portion from said pilfer band including partially scoring at least some of said ribs so that said pilfer band is at least partially detachably joined to said skirt portion by said scored ribs.

The invention may be carried into practice in various ways but a plastic closure, apparatus to make the closure and the process of making the closure, all in accordance with the present invention, will now be described by way of example with reference to the accompanying drawings, in which:

FIGURE 1 is a top plan view of the closure;

FIGURE 2 is a side elevational view in cross-section of the closure of Figure 1;

FIGURES 3A—3E diagrammatically illustrate the closure-making process and apparatus of the present invention;

FIGURES 4—6 diagrammatically illustrate the process and apparatus for compression molding of a closure in accordance with the present invention;

FIGURE 7 is a fragmentary perspective view of a portion of the closure-making apparatus illustrated in Figures 4—6;

FIGURE 8 is an enlarged, fragmentary side elevational view of a portion of the closure-making apparatus illustrated in Figures 4—6;

FIGURES 9—11 diagrammatically illustrate formation of the pilfer band portion of the closure illustrated in Figures 1 and 2.

Detailed Description

Referring to Figures 1 and 2, a plastic closure 10 formed in accordance with the present invention is illustrated. Closure 10 includes a cup-like plastic closure cap or shell 12 having a top wall portion 14 and a generally cylindrical, annular skirt portion 16 integral with the top wall portion 14. An internal thread formation 18 (shown partially cutaway in Figure 1) is provided on the inside of skirt portion 16 which is adapted to cooperate with a like thread formation on the container to which the closure is applied. The exterior of skirt portion 16 is provided with a plurality of circumferentially spaced finger ribs 20 to facilitate manipulation of the closure. Ribs 20 terminate at an annular outer shoulder 22. Cap 12 is preferably made of moldable thermoplastic, such as polypropylene or polyethylene. Other materials can also be used.

Closure 10 is of the so-called composite type, and includes a plastic sealing liner 24 disposed generally adjacent top wall portion 14. Liner 24 (shown partially cutaway in Figure 1) includes a disc-shaped central portion 26, and an annular sealing bead portion 28. Bead portion 28 is adapted to sealingly engage an outwardly facing surface of the container to which the closure is applied, thereby providing a so-called side seal. Liner 24 is preferably made of moldable thermoplastic, such as polyvinyl chloride (PVC). Other liner materials, such as ethylene vinyl acetate (EVA) can also be used. As noted, closures formed in accordance with the present invention need not include a sealing liner such as 24.

Secure retention of sealing liner 24 within cap 12 assures proper sealing of a container by the closure. To this end, cap 12 is formed with a liner-retaining annular lip 30 extending inwardly of skirt portion 16. Lip 30 (shown partially cutaway in Figure 1) is spaced from top wall portion 14, and defines an annular recess 32 therewith within which is positioned at least a portion of bead portion 28 of liner 24. A plurality of circumferentially spaced reinforcing gussets 34 extending integrally between skirt portion 16 and lip 30 can be provided for reinforcing the lip 30. Preferably, annular recess 32 is formed with a maximum internal diameter greater than the inside diameter of thread formation 18.

Notably, the configuration of lip 30, as well as gussets 34, permits the lip to exhibit some flexibility in a direction away from top wall portion 14, while resisting deflection in a direction toward the top wall portion. This facilitates removal of the lip 30 from the portion of the mold in which it is formed. This also permits some deflection of the lip 30 away from wall portion 14 when the closure is fitted to a container, which is desirable since bead portion 28 of liner 24 is deformed during sealing engagement with a container, and the one-directional flexibility of lip 30 accommodates such deformation of bead portion 28. Further, the surface of lip 30 which generally faces top wall portion 14 is non-horizontal and generally extends away from the top wall portion. This configuration of lip 30 further facilitates removal of cap 12 from the molding apparatus without damage to the lip 30.

While lip 30 provides significant retention of sealing liner 24, liner retention can be enhanced by providing at least one liner-engaging projection integral with top wall portion 14. In the preferred form, a plurality of circumferentially spaced, liner-engaging projections 36 are formed integrally with top wall portion 14 in generally normal relation thereto. Projections 36 are preferably generally cylindrical and straight-sided, and are preferably arranged in a ring in close association with annular lip 30 so that the projections 36 cooperate with lip 30 for retention of liner 24 within cap 12. Various arrangements of liner-engaging projections, and various projection sizes and configurations can be used in accordance with the teachings herein. Projections 36 can, but need not, be partially or completely disposed within annular recess 32. Projections 36 are preferably formed so as not to extend through liner 24 since that can impair proper sealing by the liner. Lip 30 cooperates with projections 36 to mechanically interlock the liner 24 with the projections.

Closure 10 includes a pilfer band 38 which may be optionally formed integrally with cap 12. Pilfer band 38 includes an annular band portion 40, and a plurality of circumferentially spaced, relatively flexible wings or projections 42 integral with band portion 40. Wings 42 are adapted to coact with an annular locking ring typically provided on a

container neck to resist removal of the closure from the container, and thereby at least partially detaching pilfer band 38 from skirt portion 16 to clearly indicate either partial or complete closure removal. Notably, the flexibility of wings 42 provide the pilfer band 38 with a "self-engaging" action during application of closure 10 to a container so that the wings are automatically positioned to properly function, without additional manipulation steps after application of the closure to a container.

Wings 42 are preferably disposed at an angle "alpha" with respect to the axis of the closure, which facilitates application of closure 10 to a container, and also facilitates proper wing formation. Additionally, wings 42 are preferably dimensioned so that they interferingly engage and coact with the portion of the container disposed immediately below its locking ring to provide the desired resistance to closure removal. Wings 42 can be formed extending angularly inwardly of band portion 40 by a preferably acute angle "beta", defined by the angle between the line of intersection of a horizontal plane with the surface of the wing (shown as phantom line H), and a line tangent to the closure. Angle "beta" facilitates formation of wings 42 having the desired dimensions for interfering coaction with the container, while permitting formation of the wings within a mold portion of relatively smaller size than if wings 42 are formed radially (angle "beta" equally 90 degrees if wings 42 are radial).

While wings 42 are illustrated as generally flat and of generally uniform thickness, other configurations can be used. For example, wings 42 may be curved or each have a compound surface. Each wing 42 may be non-uniform in thickness to facilitate flexing or folding of the wings about a selected portion, such as at the edge of each wing integral with band portion 40. The preferred configuration of the wings 42 is such that the wings may flex during removal from a molding apparatus and during application to a container without damage, yet have sufficient rigidity to interferingly engage the container without collapsing in order to indicate closure removal.

Notably, band portion 40 includes a shoulder 44 which provides clearance for deflection of the wings 42 during application of closure 10 to a container and during various closure formation operations. In one current embodiment, wings 42 have a thickness of approximately 0.305 mm, while shoulder 44 is approximately 0.331—0.356 mm wide. To assure that available clearance is sufficient for proper pilfer band formation and closure application, wings 42 are preferably spaced and dimensioned so that the wings do not overlap each other when deflected. The previously mentioned EPC specification further discusses the configuration and operation of a pilfer band such as 38.

While pilfer band 38 is preferably formed integrally with skirt portion 16, the pilfer band is at least partially detachably connected to skirt portion 16 of cap 12 to indicate closure removal. To this end, a score line 46 which extends substantially or entirely about closure 10 distinguishes band portion 40 from skirt portion 16. Detachable connection of pilfer band 38 is provided by a plurality of circumferentially spaced, internal ribs 48 which extend between and are integral with skirt portion 16 and band portion 40. As will be described, score line 46 is preferably formed so that it extends partially into at least some of ribs 48, whereby the scored ribs 48 are fracturable and provide a frangible connection of pilfer band 38 to skirt portion 16. To facilitate accurate formation of score line 46, another plurality of internal ribs 50 are provided, integral with skirt portion 16. Ribs 50 act to support the closure during scoring as will be described.

Referring to Figures 3A—3E, the basic steps of the present closure-making process are illustrated diagrammatically. These various steps will later be described in greater detail.

As shown in Figure 3A, plastic cap 12 is first compression molded between a male mold assembly 52 and a female mold 54. Optional pilfer band 38 can be integrally formed with cap 12 during this step.

Figure 3B illustrates advancement of a reorientation mandrel assembly 56 into closure cap 12 having a pilfer band 38 by movement of the cap in order to reorient the wings 42 of the pilfer band after their deformation during removal from male mold assembly 52.

As shown in Figure 3C, the detachable connection of pilfer band 38 to closure cap 12 is next provided by a scoring assembly 58 which scores the closure to provide score line 46 as the closure is rotated together with mandrel assembly 56.

Figures 3D and 3E illustrate formation of an optional sealing liner within cap 12. As cap 12 is held in position by guides 59 upon support surface 61, a quantity of moldable liner-forming plastic 60 is deposited on the inner surface of top wall portion 14 of cap 12, and a liner-forming assembly 62 thereafter advanced into cap 12. Assembly 62 includes a liner-forming plunger 64 disposed coaxially within an outer sleeve 66. Plunger 64 compresses plastic 60 to form sealing liner 24 within cap 12, as sleeve 66 engages lip 30 to restrain flow of plastic 60 between plunger 66 and 30. After assembly 62 is withdrawn, formation of closure 10 is complete.

Depending upon the type of closure desired, all process steps illustrated in Figure 3 need not be performed, and/or the sequence of the steps altered from that illustrated. For example, a closure having no sealing liner or pilfer band may be formed in accordance with the compression molding step of Figure 3A. A closure having a pilfer band but no sealing liner can be formed in accordance with the process steps of Figures 3A—3C. A closure having a sealing liner but no pilfer band can be formed by compression molding of plastic cap 12 in the process step of Figure 3A (without formation of a pilfer band), with a sealing

liner then formed as in Figures 3D and 3E. Apparatus for closure-formation can comprise integrated machinery for performing the process steps desired, or separate pieces of equipment for performing one or more of the process steps.

Referring to Figures 4—6, the compression molding apparatus and process step of Figure 3A will be described in detail. As noted, the compression molding apparatus includes male mold assembly 52 and female mold 54. Female mold 54 defines a mold cavity 68 shaped to form the exterior surfaces of plastic closure cap 12.

Male mold assembly 52 includes a male mold plunger 70 movably disposed coaxially within an outer sleeve 72. As shown in greater detail in Figure 8, plunger 70 is shaped to form the interior of closure 10. Plunger 70 defines thread grooves 76 for formation of thread formation 18, and an annular lip groove 78 for formation of annular lip 30. Plunger 70 may be provided with gusset slots 80 for formation of gussets 34 if desired. Plunger face 82 can be provided with one or more projection holes 84 for formation of liner projections 36.

Plunger 70 further defines rib slots 86 for formation of ribs 48, as well as support rib slots 88 for formation of support ribs 50. When a pilfer band 38 is formed integrally with plastic cap 12, wings 42 of the pilfer band are formed against frusto-conical surface 90 of plunger 70.

Male mold assembly 52 further includes an intermediate sleeve 92 positioned between outer sleeve 72 and plunger 70. Sleeve 92 includes a sleeve portion 94 and a rotatable mold portion 96 supported for rotation with respect to sleeve portion 94 by bearings 98. As best shown in Figure 7, mold portion 96 includes a plurality of wing slots 100 for formation of pilfer band wings 42. Mold portion 96 defines a shoulder 102 for formation of band portion 40 of pilfer band 38, and a lower surface 103 for formation of shoulder 44 of band portion 40.

Formation of closure cap 12 with integral pilfer band 38 will now be described. If a closure without a sealing liner is to be formed, portions of plunger 70 for formation of liner-retaining lip 30 and projections 36 need not be provided. Similarly, formation of a closure without a pilfer band such as 38 can be provided by eliminating mold portion 96 within which wings 42 are formed, as well as eliminating portions of plunger 70 which provide pilfer band formation.

The molding apparatus is first positioned generally as in Figure 4, and a predetermined quantity or charge of moldable thermoplastic 104, preferably molten, is deposited within mold cavity 68 of female mold 54. Female mold 54 and outer sleeve 72 are then relatively moved into engagement with each other, as indicated in phantom line in Figure 4.

Significantly, outer sleeve 72 and female mold 54 are preferably provided with frusto-conical mating surfaces which facilitate alignment of the apparatus. This is a very important feature of the apparatus. Engagement of outer sleeve 72 with female mold 54 acts to automatically correctly align the female mold with the plunger 70 reciprocably disposed within sleeve 72. Experience has shown that wear of the mold tooling is unacceptably great if sleeve 72 is not provided to facilitate alignment of female mold 54 and plunger 70 (i.e. if plunger 70 and female mold 54 are merely moved together without an outer alignment sleeve such as 72). Outer sleeve 72 is preferably spring-biased into engagement with female mold 54 to provide an alignment force of the order of hundreds of kilograms to facilitate correct alignment. This feature permits high-speed closure formation while maintaining correct finished product tolerances, a very significant advance over previous arrangements.

Compression molding of plastic charge 104 is illustrated in Figure 5. Plunger 70 and intermediate sleeve 92 are together moved within outer sleeve 72 so that plunger 70 enters mold cavity 68 and compresses plastic charge 104 to form plastic cap 12 and pilfer band 38. Wings 42 of pilfer band 38 are formed within wing slots 100 of mold portion 96, and against surface 90 of plunger 70 against which mold portion 96 is positioned during compression.

Positive compression molding of closures has been found to provide closures having less inherent stress than closures otherwise formed. Suitable air-venting channels or other arrangements can be provided to permit escape of air during compression molding of the plastic.

Preferably, compression molding pressure is of the order of 7000—14,000 KPa.

Notably, the molding apparatus is arranged to limit the maximum molding pressure to a predetermined value. This permits the apparatus to accommodate variations in the quantity of plastic charge 104 received within the apparatus. In this manner, each closure is correctly formed without undesired flashing of plastic. This molding technique results in slight variations in the thickness of the top wall portion 14 of the closure cap 12 attendant to variations in the quantity of plastic charge 104. Such variations in the top wall portion thickness do not impair the quality of the finished closure.

Preferably, the molding apparatus is arranged so that the plastic charge is initially compressed at the above relatively high molding pressure, with the molding pressure subsequently relatively lowered substantially to approximately 700—1400 KPa. This preferred procedure maintains the plastic charge in compression as the plastic sets to control closure shrinkage. By reducing the forming pressure after its initial preferred peak, a machine having multiple molding assemblies does not require the structural integrity which would be necessary if peak forming pressure is simultaneously maintained in many of the machine's molding assemblies during compression molding of closures. Similarly, a machine having multiple molding assemblies is preferably arranged to reduce the above-noted preferred alignment force provided between outer

sleeve 72 and female mold 54, again so that the structural integrity of the machine need not be excessive.

If desired, female mold 54 and male plunger 70 can be rotated with respect to each other as plastic 104 is compressed, to thereby impart spiral orientation to the plastic grain for enhancing hoop strength of cap 12. Formation of cap 12 using Phillips Chemical Company HGN-020-01 polypropylene, a Marlex polyolefin, introduced into mold cavity 68 at approximately 200—230 degrees Celsius has provided closures exhibiting the requisite strength without spiral orientation of the plastic grain.

Figure 6 illustrates removal of cap 12 with pilfer band 38 from the male mold assembly 52 so that wings 42 are not permanently damaged. As female mold 54 and male mold assembly 52 are moved out of cooperation with each other, intermediate sleeve 92 is moved upwardly. The male plunger 70 is preferably carried by intermediate sleeve 92 by a spring-biased lost motion mechanism. As sleeve 92 moves upward, outer sleeve 72 acts agains shoulder 22 of cap 12 in opposition to the spring-biasing of the lost motion mechanism to keep the plunger 70 from moving upwardly with intermediate sleeve 92. Thus, the initial movement of intermediate sleeve 92 is not imparted to plunger 70 and is "lost". By this action, wings 42 are removed from the wing slots 100 in mold portion 96. Relative rotation of mold portion 96 with respect to sleeve portion 94 permits this action without damage to the preferably angularly disposed wings 42. The preferably angularly disposed wings 42 impart rotational movement to mold portion 96 in a cam-like fashion as intermediate sleeve 92 moves upwardly a sufficient distance for the wings 42 to clear wings slots 100.

After wings 42 are free of mold portion 96, intermediate sleeve 92 and male plunger 70 move together relative to outer sleeve 72 so that sleeve 72 acts against shoulder 22 of cap 12 to strip or remove the cap 12 and pilfer band 38 from plunger 70. The resilient flexibility of cap 12 permits removal in this manner without unacceptable permanent deformation of the cap. Wings 42 of pilfer band 38 are deflected upwardly during removal, their flexible nature and their angular disposition with respect to the closure axis (angle "alpha") facilitating removal in this manner. While the above "pop-off" method of closure removal from plunger 70 is preferred, closures may be unthreaded from plunger 70 by leaving the closures at least partially within female mold 54 and relatively rotating the female mold and plunger 70 during closure removal. Alternately, closures can be unthreaded from plunger 70 by providing the lower portion of outer sleeve 72 with serrations or teeth to form like teeth on the closure meshed with the teeth of the sleeve 72, and by then relatively rotating outer sleeve 72 and plunger 70.

Referring to the process step illustrated in Figure 3B and in greater detail in Figures 9—11, reorientation of wings 42 of pilfer band 38 is illustrated. During removal from male plunger 70 as described, wings 42 are each moved in a first direction from their original molded disposition, and appear generally as in Figure 9. Disposition of wings 42 at angle "alpha" assures that all of the wings move in the same general direction. To position the wings generally in their original molded configuration for cooperation with a container, wings 42 can be reoriented by movement in a second direction opposite to the direction they are deflected during removal from plunger 70. Reorientation in this manner is provided by mandrel assembly 56. Assembly 56 includes a mandrel 110 disposed within outer sleeve 112. Outer sleeve 112 acts with mandrel 110 to reorient wings 42.

As cap 12 with pilfer band 38 is supported upon surface 116, surface 116 and assembly 56 are relatively moved toward each other. Guides 115 are provided to maintain cap 12 in position. As mandrel 110 enters and is received within cap 12, spring-biased outer sleeve 112 engages wings 42 and begins to reorient the wings. A shoulder 114 of sleeve 112 then seats against band portion 40 of pilfer band 38 as mandrel 110 and toward top wall portion 14 move toward each other and the mandrel completes reorientation of the wings 42. Mandrel 110 firmly engages top wall portion 14 of cap 12, with wings 42 urged toward band portion 40. Shoulder 44 of the band portion provides clearance to permit movement of wings 42 in this manner without excessive permanent deformation of the wings. Angle "alpha" of each wing permits proper reorientation without relative rotation of the closure and mandrel 110. When mandrel 110 and the closure are moved apart after closure scoring, the wings 42, by their resilient memory, generally resume the configuration in which they were originally molded.

Referring to Figures 3C and 11, detachable connection of pilfer band 38 to cap 12 is provided by scoring assembly 58. The scoring assembly includes a scoring knife 118 carried by a knife support 120. The closure being formed and knife 118 are brought into engagement with each other, with score line 46 preferably formed by rotation of the closure together with mandrel assembly 56 to provide a slicing-like cutting action.

Score line 46 is formed distinguishing pilfer band 38 from skirt portion 16. At least some of ribs 48 are partially cut or scored to render them frangible, thereby providing at least partial detachable connection of pilfer band 38 to cap 12. Knife support 120 is preferably arranged to engage outer sleeve 112 of mandrel assembly 56 to assure the accuracy of the depth of score line 46. Knife support 120 is preferably spring-biased into engagement with mandrel assembly 56 to compensate for any wear in the mandrel assembly to provide accurate scoring. Notably, internal support ribs 50 (as well as ribs 48) firmly engage mandrel 110 to assure correct formation of score

line 46, and to provide sufficient clearance so that knife 118 does not contact mandrel 110. Additionally, support surface 116 is preferably spring-biased so that the closure is held snugly and securely to prevent slipping during scoring.

In one current closure embodiment, ribs 48 are provided having a depth or thickness of approximately 0.355 mm and a width of approximately 0.635 mm. After closure scoring, fracturable ribs have a residual thickness of preferably approximately 0.203—0.305 mm. These dimensions are intended as illustrative since other fracturable arrangements can be formed.

If pilfer band 38 is to remain partially attached to cap 12 after removal of the closure from a container, score line 46 can be formed extending less than completely about the closure. Similarly, some of ribs 48 can be left unscored so that they are not frangible. In this regard, band portion 40 of pilfer band 38 can be scored or otherwise arranged to fail (such as by molding in of a preferentially weak area) so that during closure removal from a container, band portion 40 splits and the pilfer band remains partially attached to the cap 12. Formation of pilfer band 38 to fail in this manner is achieved by providing a suitable scoring knife for generally vertically cutting band portion 40 of the pilfer band in conjunction with partial detachable connection of band portion 40 to skirt portion 16. Such a scoring knife is preferably provided to score the band portion 40 in two places spaced from each other a distance other than the relative spacing of wings 42. In this way, band portion 40 will fail as intended even if one of the scores in band portion 40 is made at or through one of wings 42. Such scoring of band portion 40 can be made at an angle corresponding to angle "alpha" of the wings 42 to further avoid incorrect failure of the pilfer band which can result if one of the wings 42 keeps band portion 40 from failing as intended.

Referring to Figures 3D and 3E, cap 12 with pilfer band 38 appears generally as in Figure 3D after scoring and wing reorientation as described. Formation of closure 10 as shown in Figures 1 and 2 is now completed by formation of sealing liner 24.

To this end, a predetermined quantity 60 of moldable thermoplastic, preferably molten, is deposited within cap 12 against the inner surface of top wall portion 14. Liner forming assembly 62 is next advanced into cap 12 to form liner 24. Outer sleeve 66 is moved into firm engagement against annular lip 30 of cap 12. Notably, the above-described, preferred one-directional flexibility of lip 30 permits the lip to support sleeve 66, and reinforcing gussets 34 are dimensioned to permit firm engagement of the sleeve 66 with lip 30. Depending upon the desired finished dimensions of the final closure product, sleeve 66 may be provided so as to outwardly stretch cap 12 as the sleeve is advanced into the cap to provide sufficient clearance for the sleeve without undesired permanent deformation of the closure. For manufacture of some closures, particularly those in which the inside diameter of lip 30 is greater than or not much smaller than the inside diameter of thread formation 18, a stretching sleeve fitted coaxially about outer sleeve 66 can be advanced into cap 12 with sleeve 66 to stretch the cap 12 either at or above thread formation 18 so that sleeve 66 properly engages lip 30. Such a stretching sleeve can comprise a suitably slotted expanding collet having axially extending fingers arranged to expand outwardly in response to axial movement of sleeve 66 within the collet. When finished closure dimensions permit it, lip 30 is preferably formed with an inside diameter less than the inside diameter of thread formation 18 to facilitate engagement of sleeve 66 with lip 30.

After sleeve 66 engages lip 30, liner forming plunger 24 is further advanced into cap 12 to compress plastic 60 so that it flows outwardly into annular recess 32 and against lip 30 to form sealing liner 24. The liner is compression molded with pressure preferably on the order of 1000—2000 psi, with sleeve 66 restraining flow of plastic 60 between plunger 64 and lip 30. When cap 12 is formed with liner-engaging projections 36, plastic 60 flows about the projections so that the resultant liner 24 is securely mechanically interlocked with the projections. After liner-forming assembly 62 is withdrawn, formation of closure 10 is complete.

As noted, formation of some closures requires stretching of cap 12 during formation of sealing liner 24 to assure firm engagement of sleeve 66 with lip 30. Thread formation 18 can be truncated, as shown, to provide clearance for sleeve 66, but sufficient clearance must be provided so that sleeve 66 need not be excessively thin-walled.

When a lined closure is formed with pilfer band 38, stretching of only cap 12 to provide clearance for lip-engaging sleeve 66 can result in undesired failure of scored frangible ribs 48 during liner formation. Thus, formation of a closure with a sealing liner 24 and a pilfer band 28, where stretching of cap 12 is required for liner formation, requires simultaneous stretching of cap 12 and pilfer band 38 to prevent unintended failure of ribs 48. Alternately, liner 24 can be formed prior to closure scoring (formation of score line 46). When liner 24 is formed before the closure is scored, the liner-forming apparatus can be arranged to reorient the pilfer band wings 42 in the desired manner during liner formation. The closure can thereafter be scored to distinguish pilfer band 38 from skirt portion 12 to provide the desired at least partial detachable connection of the pilfer band to cap 12.

CLAIMS

1. A process of making a composite closure for a container, comprising the steps of: forming a plastic cap having a top wall portion, an annular skirt portion, an inwardly extending, annular liner-retaining lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of liner-engaging projections integral with said top wall portion and at least partially disposed

within said annular recess; depositing a quantity of moldable plastic in said cap; and forming a liner with said moldable plastic so that said moldable plastic flows into said annular recess and against said lip, said lip and said projections cooperating to retain said liner within said cap.

2. A process of making a closure as claimed in Claim 1 in which the liner forming step includes advancing a liner-forming plunger into said cap to compress said moldable plastic to form said liner, and advancing a lip-engaging sleeve into said cap coaxially with said liner-forming plunger so that said sleeve engages said lip to restrain the flow of said moldable plastic between said plunger and said lip.

3. A process of making a closure as claimed in Claim 1 or Claim 2 which includes forming a pilfer band integral with and at least partially detachably connected with said annular skirt portion.

4. A process of making a closure as claimed in Claim 3 which includes forming a plurality of ribs extending between the internal surfaces of said pilfer band and said skirt portion, and scoring said closure to distinguish said pilfer band from said skirt portion and to partially score at least some of said ribs so that said scored ribs detachably join said pilfer band and said skirt portion.

5. A process of making a closure as claimed in Claim 3 or Claim 4 in which the pilfer band includes a plurality of circumferentially spaced relatively flexible wings adapted to engage said container during removal of said closure therefrom for at least partially detaching said pilfer band from said skirt portion.

6. A process for making a composite closure for a container, comprising the steps of: compression molding a plastic cap having a top wall portion, an integral annular skirt portion, an internal thread formation on said skirt portion adapted to cooperate with a like thread formation on said container, an inwardly extending annular lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of circumferentially spaced liner-engaging projections integral with said top wall portion and at least partially disposed within said annular recess; depositing a quantity of moldable, liner-forming plastic in said cap; and compression molding said moldable plastic so that said plastic flows into said annular recess to form a sealing liner in said cap having an annular sealing bead portion at least partially disposed within said annular recess, said projections engaging said bead portion and cooperating with said annular lip to retain said liner within said cap.

7. A process for making a composite closure for a container substantially as described herein with reference to the accompanying drawings.

8. Apparatus for making a composite closure for a container, comprising: molding means for forming a plastic cap having a top wall portion, an annular skirt portion, an inwardly extending annular liner-retaining lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of liner-engaging projections at least partially disposed in said annular recess; means for depositing a quantity of moldable plastic in said cap; and means for forming a sealing liner with said moldable plastic so that said moldable plastic flows into said recess and against said lip whereby said lip cooperates with said projections to retain said liner within said cap.

9. Apparatus as claimed in Claim 8 in which said liner-forming means comprises a liner-forming plunger adapted to be advanced into said cap to compress said moldable plastic to form said liner, and means adapted to engage said annular lip while said moldable plastic is compressed.

10. Apparatus as claimed in Claim 8 or Claim 9 which includes means for forming a pilfer band having a band portion integral with said annular skirt portion and a plurality of relatively flexible projections extending integrally inwardly of said band portion, and means for forming at least one frangible connection between said skirt portion and said band portion, said flexible projections being adapted to engage said container during removal of said closure therefrom for at least partially detaching said pilfer band from said cap by fracture of said frangible connection.

11. Apparatus as claimed in Claim 10 in which said connection forming means comprises means for forming a plurality of integral ribs extending between and integral with said band portion and said skirt portion, and means for scoring said closure to at least partially distinguish said band portion from said skirt portion and to partially score at least one of said ribs to provide said frangible connection.

12. A composite closure for a container, comprising: a plastic cap having a top wall portion, an annular threaded skirt portion, an inwardly extending annular lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of circumferentially spaced projections integral with said top wall portion at least partially disposed within said annular recess, and a plastic sealing liner disposed adjacent said top wall portion and including an annular sealing band portion engaged by said annular lip, said annular lip and said projections cooperating to retain said liner within said cap.

13. A composite closure as claimed in Claim 11 in which said top wall portion is generally flat except for a single ring of said projections.

14. A composite closure for a container substantially as described herein with reference to the accompanying drawings.

15. A process of making a closure for a container having a locking ring, comprising the steps of: compression molding a plastic cap having a top wall portion, an annular skirt portion, and a pilfer band depending from said skirt portion; said pilfer band having an annular band portion at least partially detachably connected to said skirt portion and including a plurality of relatively flexible, inwardly extending projections integral with said band portion, said projections being dimensioned to engage said locking ring

during removal of said closure from said container for at least partially detaching said pilfer band from said annular skirt portion.

16. A process of making a closure as claimed in Claim 15 which includes forming said pilfer band with said projections dimensioned to interferingly engage said container below said locking ring during removal of said closure from said container.

17. A process of making a closure as claimed in Claim 15 or Claim 16 which includes forming said projections at an angle with respect to the axis of said closure.

18. A process of making a closure as claimed in Claim 15 or Claim 16 or Claim 17 in which said projections are each moved in a first direction from the orientation in which each is initially formed during removal from a mold assembly within which said closure is formed, said projections being reoriented after removal of said closure from said mold assembly by movement of each in a second direction opposite said first direction.

19. A process of making a closure as claimed in any of Claims 15 to 18 which includes detachably connecting said pilfer band to said annular skirt portion by forming said pilfer band integrally with said annular skirt portion, and thereafter scoring said closure so that said band portion is detachably connected to at least a portion of said skirt portion by frangible means.

20. A process of making a closure as claimed in Claim 19 which includes forming said closure with a plurality of ribs integral with the internal surfaces of said skirt portion and said band portion so that during said scoring at least some of said ribs are scored to provide said frangible means.

21. A process of making a closure, comprising the steps of: compression molding a plastic cap having a top wall portion, an annular skirt portion and a pilfer band depending from said skirt portion, including molding a plurality of ribs extending between the internal surfaces of said skirt portion and said pilfer band, and scoring said closure to distinguish said skirt portion from said pilfer band including partially scoring at least some of said ribs so that said pilfer band is at least partially detachably joined to said skirt portion by said scored ribs.

22. Apparatus for making a composite closure for a container, the apparatus being substantially as described herein with reference to the accompanying drawings.

New claims or amendments to claims filed on 30 Dec. 82

Superseded claims 14 to 22

New or amended claims:—

14. A composite closure as claimed in Claim 12 or Claim 13 which includes a plurality of circumferentially spaced reinforcing gussets extending integrally between said skirt portion and said annular lip for reinforcing said annular lip.

15. A composite closure as claimed in Claim 12 or Claim 13 or Claim 14 which includes a pilfer band having a plurality of relatively flexible, inwardly extending projections adapted to engage said container during removal of the closure therefrom, the pilfer band being distinguished from the skirt portion by a score line and at least partially detachably connected to the skirt portion by a plurality of frangible ribs extending between the pilfer band and the skirt portion.

16. A composite closure for a container, comprising: a plastic cap having a top wall portion, an annular threaded skirt portion, an inwardly extending annular lip spaced from said top wall portion and defining an annular recess therewith, and a plurality of circumferentially spaced liner-engaging projections integral with said top wall portion; and a plastic sealing liner disposed adjacent said top wall portion and including a relatively thick annular sealing bead portion at least partially disposed in said annular recess, said projections engaging said bead portion of said liner and cooperating with said lip to mechanically retain said plastic liner within said cap.

17. A composite closure as claimed in Claim 16 in which the liner-engaging projections are at least partially disposed in the annular recess.

18. A composite closure as claimed in Claim 16 or Claim 17 which includes a plurality of circumferentially spaced gussets extending between said skirt portion and said annular lip, said gussets being spaced from the edge of said annular lip.

19. A composite closure as claimed in Claim 16 or Claim 17 or Claim 18 which includes a pilfer band at least partially detachably connected to the skirt portion by a plurality of frangible ribs, the pilfer band being distinguished from the skirt portion by a score line, and including a plurality of relatively flexible, inwardly extending projections adapted to engage the container during removal of the closure therefrom for at least partially detaching the pilfer band from the skirt portion.

20. A composite closure for a container substantially as described herein with reference to the accompanying drawings.

21. A process of making a closure for a container having a locking ring, comprising the steps of: compression molding a plastic cap having a top wall portion, an annular skirt portion, and a pilfer band depending from said skirt portion; said pilfer band having an annular band portion at least partially detachably connected to said skirt portion and including a plurality of relatively flexible, inwardly extending projections integral with said band portion, said projections being dimensioned to engage said locking ring during removal of said closure from said container for at least partially detaching said pilfer band from said annular skirt portion.

22. A process of making a closure as claimed in Claim 21 which includes forming said pilfer band with said projections dimensioned to interferingly engage said container below said locking ring during removal of said closure from said container.

23. A process of making a closure as claimed in Claim 21 or Claim 22 which includes forming said

projections at an angle with respect to the axis of said closure.

24. A process of making a closure as claimed in Claim 21 or Claim 22 or Claim 23 in which said projections are each moved in a first direction from the orientation in which each is initially formed during removal from a mold assembly within which said closure is formed, said projections being reoriented after removal of said closure from said mold assembly by movement of each in a second direction opposite said first direction.

25. A process of making a closure as claimed in any of Claims 15 to 18 which includes detachably connecting said pilfer band to said annular skirt portion by forming said pilfer band integrally with said annular skirt portion, and thereafter scoring said closure so that said band portion is detachably connected to at least a portion of said skirt portion by frangible means.

26. A process of making a closure as claimed in Claim 25 which includes forming said closure with a plurality of ribs integral with the internal surfaces of said skirt portion and said band portion so that during said scoring at least some of said ribs are scored to provide said frangible means.

27. A process of making a closure, comprising the steps of: compression molding a plastic cap having a top wall portion, an annular skirt portion and a pilfer band depending from said skirt portion, including molding a plurality of ribs extending between the internal surfaces of said skirt portion and said pilfer band, and scoring said closure to distinguish said skirt portion from said pilfer band including partially scoring at least some of said ribs so that said pilfer band is at least partially detachably joined to said skirt portion by said scored ribs.

28. Apparatus for making a composite closure for a container, the apparatus being substantially as described herein with reference to the accompanying drawings.

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